



Chapter 15

SCAR FORMATION

KEY FIGURES:

Hypertrophic scar
Buried dermal suture

This chapter gives background information about the scarring process. Treatment options for problematic scars are also discussed.

Normal Course of Scar Maturation

Strength

Scar tissue is never as strong as normal, uninjured skin. For the first 3–4 weeks after injury, the wound can easily be reopened by minimal trauma. By 6 weeks, the scar has attained approximately 50% of its final strength. During the next 12 months, the scar gradually increases its ability to withstand injury, but it never attains normal strength.

Appearance

The period of maximal collagen production (the primary component of skin and scar tissue) is the first 4–6 weeks after a wound has closed. During this period the scar may appear red and be slightly firm and raised.

Over the next several months, changes in the rate of collagen production and degradation occur. Normal healing results in normal types and amounts of collagen in the area. On the surface, normal healing is illustrated by the fading of redness and softening of the scar.

I usually tell patients that it will take at least 1 year for the scar to achieve its final appearance. Scars in children may continue to change and improve for several years.

Abnormal Scarring

For various reasons, such as genetics, nature of initial injury, or bad luck, some scars become exceptionally red, thick, and tight. Such scars can be problematic on the hand or other flexor surfaces, because they may lead to limitation of movement and loss of function.

Hypertrophic scars are a bit thicker and redder than the fine scar that usually results after primary healing. At the extreme, scars may become **keloids**—that is, they may enlarge beyond their initial area. Keloids can become large and unsightly. They also can cause annoying symptoms, such as itching and pain.



Typical hypertrophic scar. Note that the scar is thick and raised but still within the confines of a normal scar.

In addition, the scar may be **unstable**. An unstable scar is easily re-injured with minimal trauma; it heals but is easily injured again. This cycle can go on for years and ultimately result in the development of an aggressive form of skin cancer.

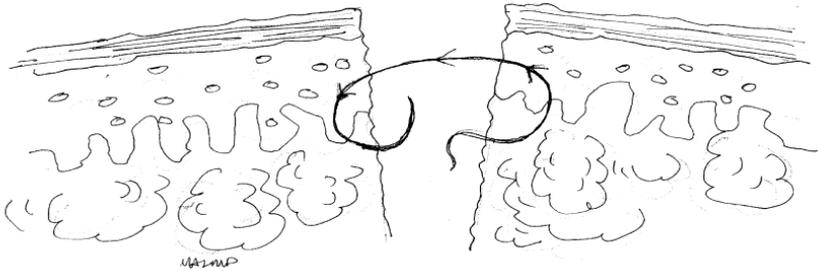
Abnormal scarring is usually the result of abnormal collagen production and degradation. Although we do not know the exact cause of these abnormal processes, the manner in which a wound is closed may play a role. In addition, there are interventions that can improve an abnormal scar.

Method of Wound Closure

Primary Wound Closure

Usually, the best (i.e., least noticeable) scar results when a wound is closed by suturing (i.e., the skin edges together). Usually the sutures are removed before the 14th day after repair. As explained above, at this point the scar is not very strong; in fact, it has < 15% of its final strength. Normal everyday movements will pull on the scar and may result in widening of the scar.

For this reason, most plastic surgeons place buried dermal sutures as well as the usual skin sutures when they close a wound (see figure below). Buried dermal sutures are not difficult to place, but this extra step is time-consuming. The dermal sutures add strength to the repair site during the weeks to months required for their absorption. The anticipated result is less widening and an improved appearance of the scar.



Buried dermal sutures are used to hold together the skin edges and thereby decrease tension on the external sutures. In theory, placement of a few buried dermal sutures decreases the risk for hypertrophic scarring and keloid formation.

When dermal sutures are not used, be sure that the skin sutures provide good dermis-to-dermis approximation. It also is important to remove the sutures at the appropriate time (see chapter 1, "Suturing: The Basics"). Sutures that are left in place too long cause an inflammatory response that worsens scar appearance.

If Steristrips are available, put them across the suture line when the sutures are removed. This simple step gives the scar a bit of extra strength during the period when it is vulnerable to injury.

Secondary Wound Closure

Wounds that are allowed to heal secondarily often have larger, more noticeable scars than ones closed primarily. Secondary wound closure

also is associated with a higher incidence of hypertrophic scarring and keloid formation.

How the Patient Can Help

Once the sutures have been removed and the wound looks well healed, **rubbing or gently massaging the scar** with a mild moisturizing cream (e.g., Vaseline, aloe, cocoa butter) a few times each day promotes softening and lightening of scar tissue, especially on the face and hands. A cream with vitamin E may be helpful. Patients should not spend a large sum of money on fancy creams because no conclusive evidence indicates that expensive formulations improve the scar's final appearance. Gentle massage should be continued for at least 4–6 weeks.

Patients should stay out of the sun as much as possible, and always **use a sunscreen** (SPF > 20). Scars exposed to the sun (especially if sunburn develops) not only stay red longer but also may not fade as much as normally expected.

All patients should **maintain good nutrition**, and diabetics should maintain good glucose control.

Providers must counsel patients aggressively about the **ill effects of tobacco products** on wound healing. Some of the components in cigarettes cause a decrease in blood circulation to the skin, which results in poor wound healing and may even lead to tissue loss. Dramatic adverse reactions due to the effects of smoking have been reported.

Interventions for Problematic Scars

Scars that are Too Tight

These treatments can be tried individually or in some combination.

Gentle Massage

Instruct the patient in the massage techniques described above.

Silicone Gel Sheets

Once the sutures have been removed and the wound looks well healed, you can cover the wound with silicone gel sheets. Although it is not entirely understood how they work, silicone gel sheets can be quite effective. They can be obtained from pharmacies but usually require a prescription (although this policy is changing in the United States).

How to use the silicone gel sheet

1. Cut a piece large enough to cover the scar completely.
2. The sheet should be left in place as long as tolerated—even all day. The longer it is in place, the better.
3. The patient should remove the sheet to wash. Deodorant soaps should not be used to cleanse the area; they may cause a rash. One piece of gel sheet can be used repeatedly.
4. Sheets should be used for at least 2–3 months to make an appreciable difference.

Splinting

The purpose of splinting is to prevent loss of function and restriction of movement from a tight scar. Especially on the hand and in a crease, splinting can be quite useful. The splint should be molded so that it stretches the tight scar.

Case example: If a tight scar across the front of elbow prevents the patient from fully extending the forearm, the following steps may help:

- Make a splint that holds the elbow in as much extension as tolerated. Gradually the scar will become less tight because of the remodeling due to splinting and scar massage (remember, you can add other “scar is too tight” treatments). With time the patient will be able to extend the elbow more fully.
- The splint can be made out of simple plaster of Paris (see chapter 28, “Hand Splinting and General Aftercare”).
- If the splint interferes with the patient’s ability to work, encourage the patient to wear it at night.
- New splints should be made as the patient can more fully extend at the elbow.
- This process may take many months, but is worth the effort to improve function.

Pressure Garments

Pressure garments, measured and fitted to the individual patient, can be worn under everyday clothing. They are designed to apply continuous pressure over the area of concern. Theoretically, the pressure causes the underlying scar to become ischemic and thus leads to remodeling.

Pressure garments should be worn 18–24 hours/day for a minimum of 4–6 months. Medical supply stores and pharmacies can order pressure garments, which are expensive. Prescriptions usually are required.

Scars that are Too Red

Reassurance and Reminders

Reassure the patient that scars will fade on their own, but the process takes time. Remind the patient to avoid sun exposure whenever possible and to use sunscreen when exposure cannot be avoided. Ultraviolet light injures normal skin as well as scars. A sunburned scar may not fade as well as normally expected.

Make-up

Once the sutures have been removed and the wound looks well healed, the patient can apply gentle make-up until the scar fades on its own. It is best to use make-up with a sunscreen to prevent sun injury. Make-up alone does not protect the tissues from the ill effects of the sun.

Keloids and Hypertrophic Scars

Try the treatments described under “Scars that are Too Tight.” Massage, silicone gel sheets, splinting, and pressure garments may help. In addition, the treatments listed below may be useful. Each can be tried individually, but often they work better in combination with another method. For example, inject the keloid with steroids and use a pressure garment daily. Or excise the keloid, close the wound meticulously, and then use silicone gel sheeting after the sutures have been removed.

Steroid Injection

Inject triamcinolone acetonide into the dermis of the keloid—approximately 1 mg for every 1–2 cm of scar. It is best to use a tuberculin syringe because you are working with small amounts of medication. Be sure to check the mg/ml of the solution (different bottles may have different drug concentrations). The total amount of injected triamcinolone should not exceed 30 mg.

Caution: Steroid injection hurts. You can add 0.5–1.0 ml of lidocaine to the steroid solution.

It takes several weeks to see any noticeable change in the scar. Steroid injection can be repeated after 4–6 weeks, but I do not recommend injecting the same area more than 2 or 3 times. The response to steroid injection is quite variable. The reported percentages of patients obtaining some improvement (not necessarily resolution of the scar) after steroid use range from 50% to 100%.

The patient should be warned of the risks associated with the injection of steroids. Infection may develop at the injection site, and the injected

area may become lighter in color than the surrounding skin. Be especially careful in treating diabetic patients. Steroids may cause an elevation of blood glucose level.

Pressure Earrings

Some patients develop keloids after ear piercing. Earrings designed to apply pressure to the earlobe are commercially available. They work best on small keloids (< 1 cm). Pressure earrings are especially useful when combined with excision of the keloid. Once the excision sutures have been removed, the patient should wear the earring for at least 2 or 3 months (longer is better). This approach may prevent recurrence of the keloid.

Excision

Caution: Excision of a keloid often results in formation of another keloid. The recurrence rate after excision ranges from 45% to 100%.

At times, however, it is worthwhile to excise the bothersome keloid. For example, patients with a keloid associated with ear piercing may have a successful outcome if, as previously described, after excision they wear a compression earring regularly. Another example when excision may be successful is if the initial injury was not closed with sutures (i.e., it was allowed to heal secondarily). In this case, excision of the keloid followed by primary skin closure may be helpful. Even under these more favorable circumstances, you must warn patients that the keloid may recur.

If you excise the keloid, a close dermal approximation of the skin edges is especially important. Close approximation requires placement of buried dermal sutures prior to skin closure. Therefore, excision of a keloid and primary closure should be undertaken only by clinicians with excellent suturing skills.

Radiation Therapy

If radiation therapy facilities are available, low-dose therapy helps to prevent the development of a keloid. Usually it is performed only on patients known to develop severe keloids who are scheduled for surgical procedures. The radiation is administered as early as the first post-operative day.

As with other treatment methods, the success rate is variable, ranging from 10% to 94% in different studies.

Unstable Scars

When larger wounds or wounds over creases are allowed to heal secondarily, the scar may be easily injured and reopen. Although usually it heals with local wound care measures, this cycle often repeats itself again and again. Excision of the entire scar may be indicated. The resultant skin defect requires closure with a more durable skin graft or flap (see chapters 12, 13, and 14 on “Skin Grafts,” “Local Flaps,” and “Distant Flaps” for details about these techniques).

Bibliography

Niessen FB, Spauwen PHM, Schalkwijk J, Kon M: On the nature of hypertrophic scars and keloids: A review. *Plast Reconstr Surg* 104:1435–1458, 1999.